1 GENERAL

1.1 Scope of Specification

This specification covers the minimum performance requirements for vertically or horizontally polarised antennas to be used in the band 40.5 to 42.5 GHz allocated to multipoint video distribution services. Two types of antennas are included, one directional ($\leq$ 64 degrees) and an omnidirectional type. Omnidirectional antennas could be specified by the licence applicant but the Licensing Authority in most cases is expected to specify that directional antennas are used to improve spectrum efficiency. Omnidirectional pattern antennas will in general only be permitted in areas remote from other centres of population or separated by elevated terrain.

1.2 Licensee's Responsibility

The use of MVDS transmission equipment is subject to the issue of a licence by the Secretary of State. Under the conditions of the licence it will be the responsibility of the licensee to ensure that the equipment provided conforms with and is maintained to the requirements of this specification. The requirement in this case is that the antenna shall be type-approved.

1.3 Labelling

Complete antenna assemblies shall be clearly identified with a weatherproof and permanent mark (or marks) showing the manufacturer's name and type number. Additionally the antenna shall display marks indicating the following:

(a) The vertical direction for installation.

(b) The direction of polarisation.

(c) The azimuth reference.

1.4 Declarations

When submitting an antenna for type approval the manufacturer shall supply the following:-

(a) the type of antenna, i.e. directional or omnidirectional.

(b) the nominal antenna gain. (dBi)

(c) 3dB beamwidth (in the case of the directional antenna)

1.5 Test Arrangements

All performance testing of antennas will be carried out at a test site specified by the testing authority. Testing shall be carried out on dry antennas.

NOTE: Radomes shall be fabricated from hydrophobic materials to minimise the effect of water droplets on the radiation pattern. Testing of wet antennas is under consideration. Arrangements will be made for the applicant to deliver the antenna to the test site at least two weeks before testing is scheduled to begin.

Manufacturers may be required to participate in the mounting and dismantling of the antenna. Applicants will normally be expected to make arrangements to remove their antennas from the test site within 14 days of receiving notification from the testing authority that tests have been completed.

NOTE: Tests may from time to time be cancelled or postponed at short notice due to unsuitable weather conditions.

1.6 Polarisation

The mark indicating the plane of polarisation of radiation shall be within ± 1° of the actual plane and the installation ± 3° of the indicated plane.

1.7 Offshore Environment

Antennas to be used offshore shall additionally meet the environmental requirements of Chapter 2 of Radiocommunications Agency specification MPT 1405.

1.8 Interpretation of this Specification

In case of doubt about the interpretation of this specification the decision of the testing authority shall be final.

1.9 Testing Authority

The testing authority shall be Radiocommunications Agency or one approved by the Agency.

2 Technical Requirements

2.1 Definitions

Radiation pattern — A diagram relating power flux density at a constant distance from an antenna to the direction relative to the antenna main beam. The distance is required to be greater than the minimum far-field distance of the antenna under test or the reference antenna used for the radiation pattern measurements whichever is the larger. The minimum far-field distance is given by the following formula:

$$\textit{Minimum far-field distance} = 6.7D^2F \quad \textit{Metres}$$

where: D is the aperture diameter of the larger of the antenna under test or the reference antenna, expressed in metres.
F is the frequency in GHz.

Radome	A cover for an antenna system which is weatherproof and intended to be transparent to radio frequency energy.
Gain pattern	A diagram representing the radiation pattern of an antenna under test, when the source antenna is similarly polarised, scaled in dBi or dB relative to the measured antenna gain and in degrees relative to the marked direction.
Main Lobe	The radiation lobe containing the direction of maximum radiation.
Beam of an antenna	The main lobe of the radiation pattern of an antenna.
Antenna gain	The power ratio of signal strength measured in the reference direction to the signal strength that would exist at the same distance if the antenna was replaced by an isotropic lossless radiator. The antenna gain is expressed in dB above isotropic level and is denoted by dBi.
Test Range	A facility for recording radiation characteristics and for presenting patterns as if measured in the far field.
Polarisation	The orientation of the electric field.

2.2 Minimum Performance Requirements

This section describes the approval test requirements, method of measurement and specification limits for the [sector coverage and omnidirectional] antennas.

2.2.1 Approval Test Requirements

Approval tests will be conducted on the following antenna performance parameters:

(a) Gain

(b) Azimuth Radiation Pattern

(c) Elevation Radiation Pattern

The values measured during the approval tests shall meet the limits outlined in Section 2.2.3, below.

2.2.2 Method of Measurement

Measurements shall be made at the test frequencies 40.5 GHz, 41.5 GHz and 42.5 GHz. The testing authority reserves the right to test at additional frequencies within the frequency range 40.5 GHz to 42.5 GHz should it be deemed necessary. If the antenna is designed for use with a radome or feed shroud, then measurements shall be made with this in place.

(a) Gain

The method of gain measurement shall be proposed to and agreed with the testing authority at least 2 weeks prior to the approval test.

(b) Azimuth Radiation Pattern

The radiation pattern polar response shall be measured on a far field range, in the azimuth plane. The co-polar patterns and cross-polar patterns are measured at the test frequencies referred to above. The azimuth pattern will be recorded by mounting the antenna in its normal orientation (0° elevation) onto a single axis positioner. The antenna shall be rotated about the positioner local vertical axis between -180 and +180 degrees; the signal level received from the transmitting antenna at a fixed point shall be recorded as a function of the transmitting antenna angle.

(c) Elevation Radiation Pattern

The radiation pattern polar response shall be measured on a far field range, in the elevation plane. The co-polar patterns and cross-polar patterns are measured at the test frequencies referred to above. The elevation pattern is measured by mounting the antenna at 90 degrees to its normal attitude and rotating about the positioner local vertical axis between -180 and +180 degrees; the signal level received from the transmitting antenna at a fixed point shall be recorded as a function of the transmitting antenna angle.

2.2.3 Specification Limits

(a) Gain

The measured antenna gain shall meet the requirements specified in Table 3.1 and be within ± 1 dB of the value declared in 1.4.

TABLE 3.1 ANTENNA GAIN

Antenna Type	Gain dBi max
64 Degree	15
Omnidirectional	8

(b) Radiation Pattern

The values of the gain of the measured co-polar and cross-polar patterns of the 64° antenna in the azimuth and elevation planes shall be equal to or less than the values given in Figures 3.1 and 3.2.

For the omnidirectional antenna, the measured azimuth co-polar pattern of the antenna shall be within ± 3 dB of the gain measured in 2.2.2(a). The azimuth cross-polar discrimination shall be better than 30 dB. The elevation radiation pattern shall comply with Fig. 3.2.

Fig 3.1 Limits of Antenna Gain for MVDS 64° Angle Antenna

Azimuth Radiation Pattern

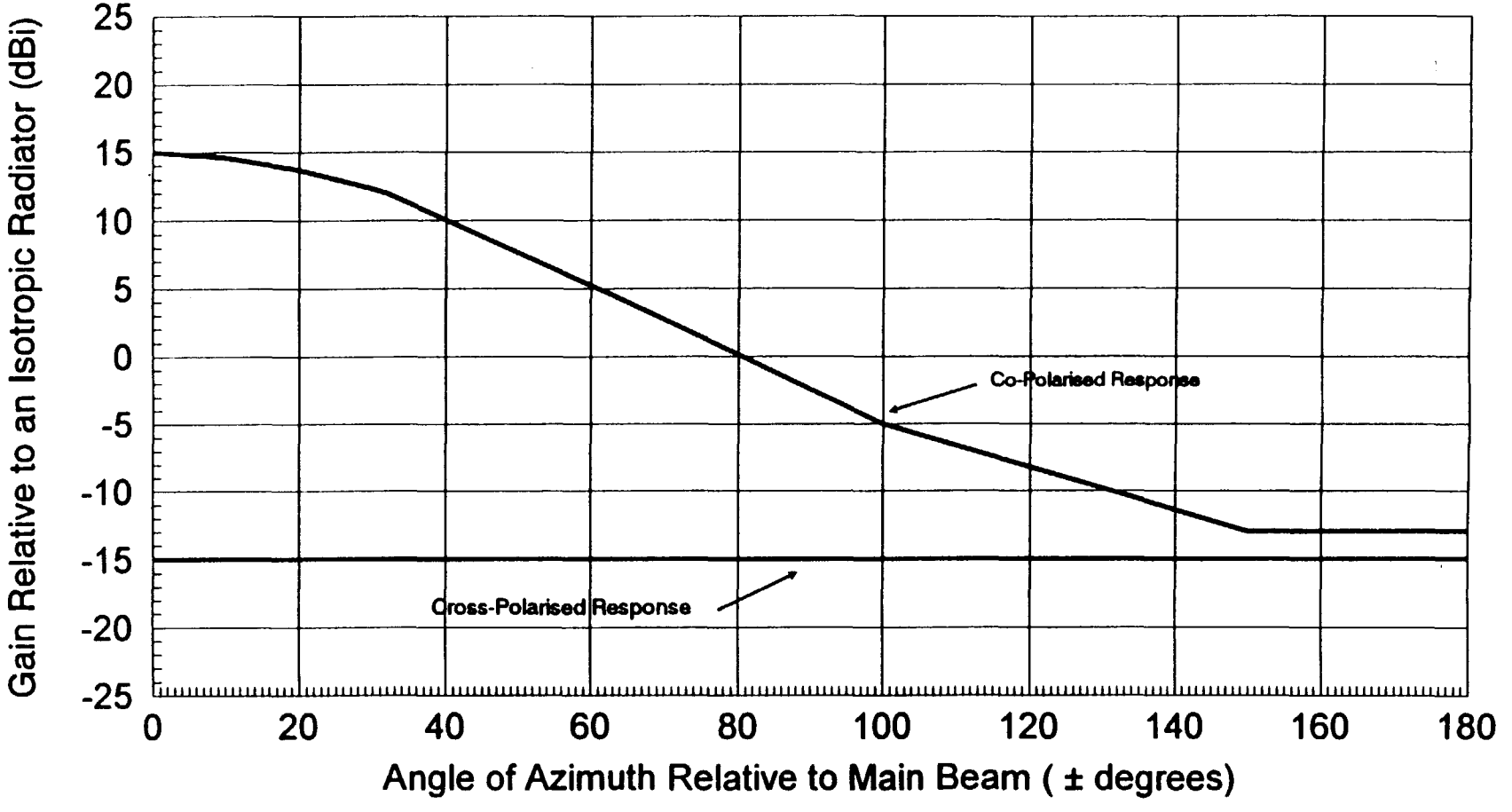
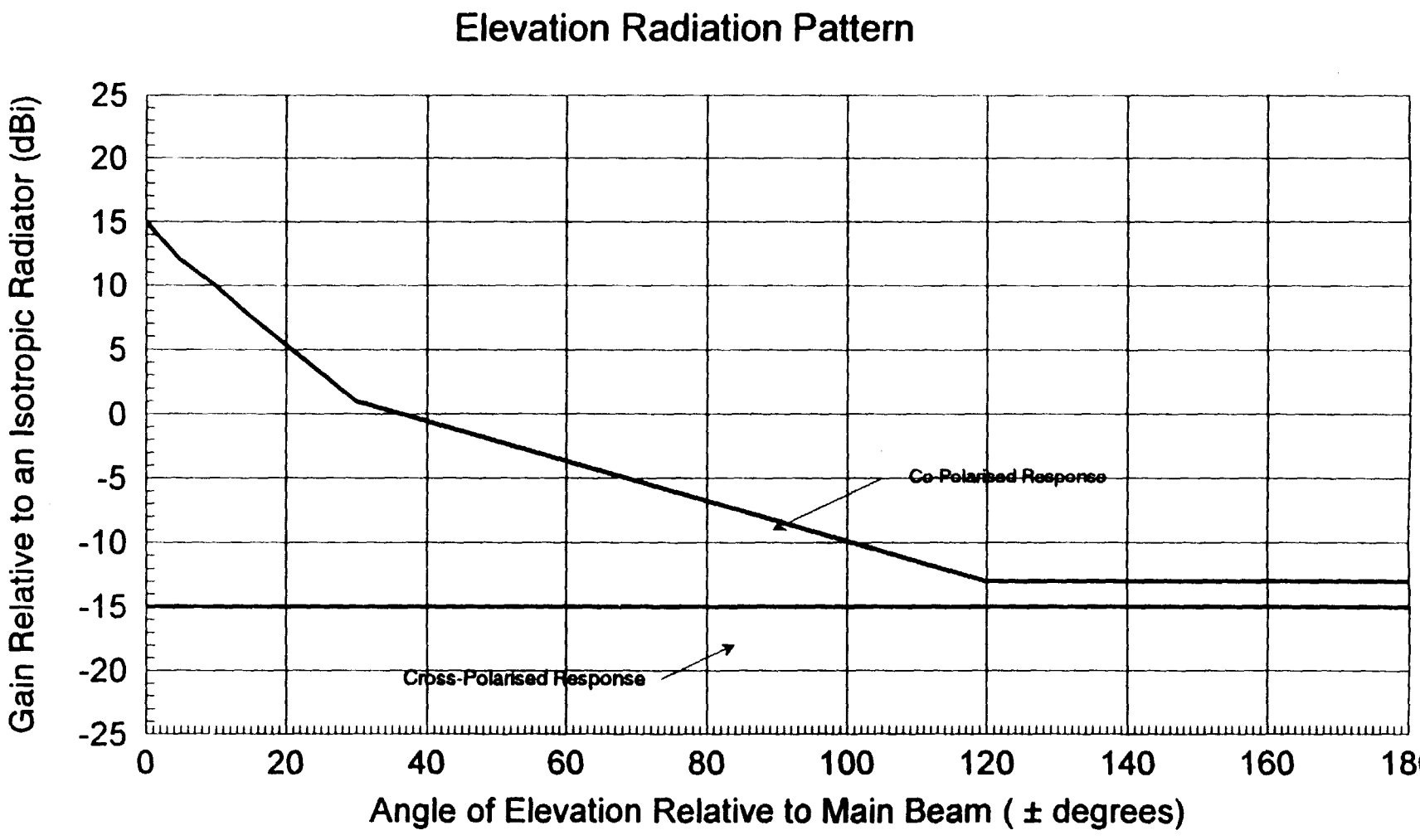


Fig 3.2 Limits of Antenna Gain for MVDS 64° Angle Antenna



ANNEX 1

RECEIVER PERFORMANCE

Performance of Outdoor/Indoor Units for information (assumed in drawing up specification)

a) Outdoor Unit

Frequency range	40.5 - 42.5 GHz
Noise figure (including 2 dB filter insertion loss)	≤ 11 dB
Gain of receiving aerial	32 dBi
Polarisation of receiving aerial	Horizontal/Vertical
Frequency of local oscillator (Ch 1 - 64) (Ch 65 - 128)	42.41375 GHz 40.57025 GHz
Stability of local oscillator	± 5 MHz
Channel polarisation (odd numbers) (even numbers)	Horizontal Vertical
Rejection of 1st image frequency	> 35 dB

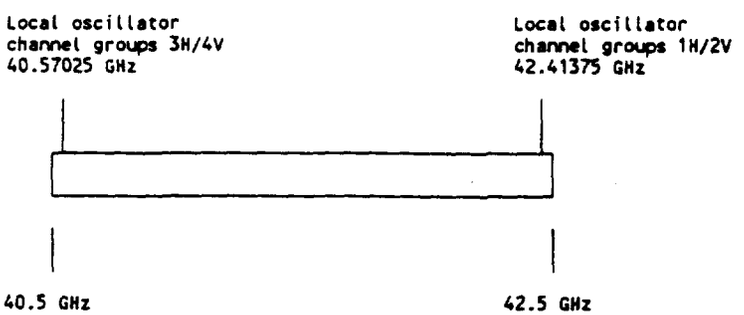
b) Indoor Unit

Frequency range	0.95 - 1.95 GHz
Signal input at 1st I.F. to reach fm demodulation threshold and to achieve 48 dB weighted S/N	-60 dBm (Z_{in} = 75 Ω nominal)
Maximum tuning error for worst selected channel	± 0.25 MHz
Rejection of adjacent (N + 2) odd or even channels	25 dB
Channel bandwidth	26 MHz nominal
Frequency range of modulated UHF output	Channels 32 - 40
Characteristics of baseband video output:	
Bandwidth	25 Hz - 10.5 MHz ± 2 dB to 8.4 MHz ± 3 dB to 10.5 MHz
Group delay error	< 25 ns
Peak/peak output level	1 Volt nominal
Output impedance	75 Ω nominal (return loss > 20 dB)
De-emphasis	selectable to CCIR REC.405-1 or EBU MAC / Packet specification Tech. 3258
Baseband sound output	European Standard EN50049 'PER TELEVISION

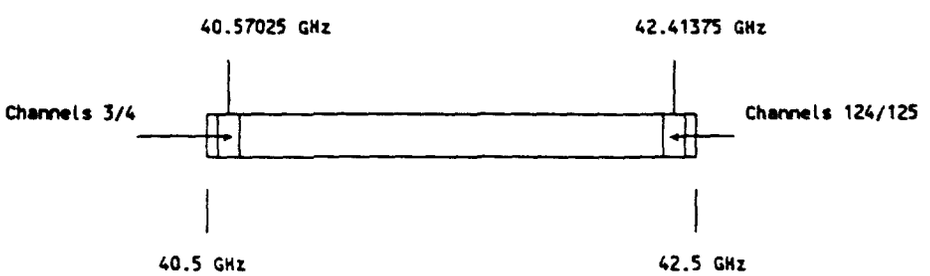
ANNEX 2

LOCAL OSCILLATOR FREQUENCIES AND CHANNEL PLAN

(Assumed in drawing up specification)



Position of local oscillator frequencies within MVDS spectrum



Position of local oscillator frequencies within MVDS channels

ANNEX 2
GROUPS 1 & 2 CHANNEL PLAN

Channel Group 1 Horizontal Polarisation		Channel Group 2 Vertical Polarisation	
Channel Number	Nominal Centre Frequency of Channel (GHz)	Channel Number	Nominal Centre Frequency of Channel (GHz)
1	40.53500	2	40.54975
3	40.56450	4	40.57925
5	40.59400	6	40.60875
7	40.62350	8	40.63825
9	40.65300	10	40.66775
11	40.68250	12	40.69725
13	40.71200	14	40.72675
15	40.74150	16	40.75625
17	40.77100	18	40.78575
19	40.80050	20	40.81525
21	40.83000	22	40.84475
23	40.85950	24	40.87425
25	40.88900	26	40.90375
27	40.91850	28	40.93325
29	40.94800	30	40.96275
31	40.97750	32	40.99225
33	41.00700	34	41.02175
35	41.03650	36	41.05125
37	41.06600	38	41.08075
39	41.09550	40	41.11025
41	41.12500	42	41.13975
43	41.15450	44	41.16925
45	41.18400	46	41.19875
47	41.21350	48	41.22825
49	41.24300	50	41.25775
51	41.27250	52	41.28725
53	41.30200	54	41.31675
55	41.33150	56	41.34625
57	41.36100	58	41.37575
59	41.39050	60	41.40525
61	41.42000	62	41.43475
63	41.44950	64	41.46425

Frequency of first local oscillator for channel groups 1 & 2 = 42.41375 GHz
Range of first IF channels for channel group 1 = 964.25 to 1878.75 MHz (H)
Range of first IF channels for channel group 2 = 979.00 to 1893.50 MHz (V)

ANNEX 2
GROUPS 3 & 4 CHANNEL PLAN

Channel Group 3 Horizontal Polarisation		Channel Group 4 Vertical Polarisation	
Channel Number	Nominal Centre Frequency of Channel (GHz)	Channel Number	Nominal Centre Frequency of Channel (GHz)
65	41.53500	66	41.54975
67	41.56450	68	41.57925
69	41.59400	70	41.60875
71	41.62350	72	41.63825
73	41.65300	74	41.66775
75	41.68250	76	41.69725
77	41.71200	78	41.72675
79	41.74150	80	41.75625
81	41.77100	82	41.78575
83	41.80050	84	41.81525
85	41.83000	86	41.84475
87	41.85950	88	41.87425
89	41.88900	90	41.90375
91	41.91850	92	41.93325
93	41.94800	94	41.96275
95	41.97750	96	41.99225
97	42.00700	98	42.02175
99	42.03650	100	42.05125
101	42.06600	102	42.08075
103	42.09550	104	42.11025
105	42.12500	106	42.13975
107	42.15450	108	42.16925
109	42.18400	110	42.19875
111	42.21350	112	42.22825
113	42.24300	114	42.25775
115	42.27250	116	42.28725
117	42.30200	118	42.31675
119	42.33150	120	42.34625
121	42.36100	122	42.37575
123	42.39050	124	42.40525
125	42.42000	126	42.43475
127	42.44950	128	42.46425

Frequency of first local oscillator for channel groups 3 & 4 = 40.57025 GHz
Range of first IF channels for channel group 3 = 964.25 to 1878.75 MHz (H)
Range of first IF channels for channel group 4 = 979.00 to 1893.50 MHz (V)

RADIOCOMMUNICATIONS
AGENCY

ORIGINAL

40GWG(94)16
7 December 1994

40 GHZ MVDS WORKING GROUP

Microwave Video Distribution Systems

Attached, for the information of the 40GHz Working Group, is a copy of a report prepared by Ian Clarke, Business Development Manager, of Phillips Microwave, on the 1994 position for Microwave Video Distribution Systems.

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TELECOM TRENDS® INTERNATIONAL

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Conference: CCA Development Series - New Technology - 16 November 1994
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Microwave Video Distribution Systems - The 1994 Position

Microwave Video Distribution Systems (MVDS) have been proposed at a number of frequencies: 2,5 GHz, 12 GHz, 29 GHz and 42 GHz. Whilst there remains a place for systems at the lower frequencies, the demand in the developed world for interactive broadband multimedia delivery implies the use of the higher frequencies.

Millimetric MVDS was first proposed in Europe by BT, who envisaged a one-way broadcast system filling a niche between satellite and cable distribution. Radio enabled local tailoring of services, but avoided the high initial cost of cable. Three scenarios were foreseen: cable substitution, cable supplement and cable pullthrough. BT were able to demonstrate at their Saxmundham technical trial, and in the joint commercial demonstration with Granada T.V., the viability of the approach.

The UK Radiocommunications Agency (RA) selected the 40,5 to 42,5 GHz ITU broadcasting band for MVDS in August 1989. A working group was established to create the necessary technical, planning and licensing rules. The technical output of the group was embodied in transmitter and antenna specifications (MPT 1550, September 1993) and a report, taking the form of an Applications note. Since then, CEPT have also adopted this band for use across Europe.

The UK Broadcasting Act (1990) included provision for MVDS services, with franchises to be awarded competitively by the Independent Television Commission, (ITC). New, 'technology neutral' licences would be awarded in future, and existing cable franchises could opt to have their licences converted to the new 'Local Delivery Service', (LDS). Franchises also require licences under the Wireless Telegraphy Act for radio transmission.

The concept of MVDS is essentially cellular, and MPT 1550 provides for a four frequency set: two true frequency blocks together with the use of both vertical and horizontal polarisation. However, the ITC and RA have decided that it is not necessary to formulate a national cellular plan. New bids for LDS licences are made under the same rules, whether it is intended to use cable or MVDS. First, a potential franchisee identifies an area or community of interest, and lodges an application with the ITC. The ITC may then modify the boundary of the area if this is in the interests of increased competition, and formally advertises the area. The franchise is awarded to the highest bidder, taking into account the number of households within the area boundary to be offered the services.

Bids must include a technical plan, showing the areas to be reached by radio, the frequency plan and the interference protection ratios provided between the franchise cells, and more importantly, to future possible adjoining franchises. The onus is therefore entirely on the applicant to arrive at a suitable technical scheme.

MPT 1550 has been drafted to provide the maximum commonality between MVDS and satellite DTH receivers. Channel separations and bandwidths are therefore 29,5 MHz (copolar) and 26 MHz respectively. The four frequency set, therefore, comprises 32 channels per household. The frequency stability of the transmitter is specified as $\pm$ 0,5 MHz, and MPT 1550 also provides a spectrum and spurious transmission mask. Two antenna specifications are given: one for 64 degree sector coverage (i.e. radiation from the cell perimeter) and one for an azimuth omnidirectional antenna. The specification states that the former will normally be required, on frequency re-use grounds.

All the other system parameters, including transmit power, receiver noise figure, picture quality and service availability are unspecified, although typical values are given for planning guidance.

The transmitter power guideline of 200mW per channel is based on a review of solid state and travelling wave tube state of the art in 1991. This still represents a realistic affordable value, although by 1996 powers of up to 1W per channel could be available using pseudo-morphic HEMT devices. Similarly, the 9 dB receiver noise figure could become 5 dB with the use of p-HEMT low noise preamplifiers.

By analogy with DBS, the RA discussion documents suggests a quality criterion of C/N = 12 dB for 1% of worst month, or 0,3% of time, giving a received picture quality of CCIR impairment grade 4.

The 'first cut' LDS technical plan is prepared by reviewing the available hardware specifications, adopting a quality criterion, establishing the rainfade, rain depolarisation, and troposcatter effects for the geographical area, and using these data to establish cell sizes, transmitter sites and a frequency plan. Digital map data bases may then be used to add detail to the plan. The overheads presented below illustrate a typical process.

However, this all presupposes that the service to be provided is based on analogue F.M. unidirectional transmission. It is now expected that at least some channels of DTH satellite and cable will adopt the MPEG-2 digital format during 1995. The former will use QPSK and the latter 64 QAM. An MVDS digital service would naturally employ DTH receiver equipment with a 42 GHz downconverter; what is required is a low cost QPSK transmitter.

Service ranges and frequency plans for the QPSK option are now in active discussion. The RA and ITC have indicated that the 40 GHz Working Group will be reconvened this Autumn, to establish a digital MPT specification.

One possible route is to treat each analogue FM transmitter as a broadband composite datastream transponder. Typical MPEG-2 compression results in data rates of between 2MBit/s and 6MBit/s for typical entertainment channels. To achieve the necessary bit error rates (typically better than 10 EXP-11) at a C/N ratio of typically 8 or 9 dB, requires sophisticated forward error correction. However, at least 24 MBit/s of useful data could be carried at a 29,5 MHz channel spacing. The number of programmes per household will thus increase from 32 to at least 128.

To provide a service fully equivalent to broadband cable, it is also necessary to provide a return path, with a sufficient datarate to allow for interactivity and telephony. Values of between 6,4 kBit/s and 128 kBit/s have been suggested. The return path technology chosen will depend on the type of service and whether any infrastructure is already in place. For example, in parts of Europe, a PTT might choose to install MVDS with a copperwire return; or the similarity in cell size between GSM, DECT and MVDS could be exploited; finally, a 'greenfield' franchisee could require a millimetrewave return path, perhaps sharing the 42 GHz band. All of these scenarios would require changes to UK and/or EC regulations.

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Microwave

Video

Distribution

Systems

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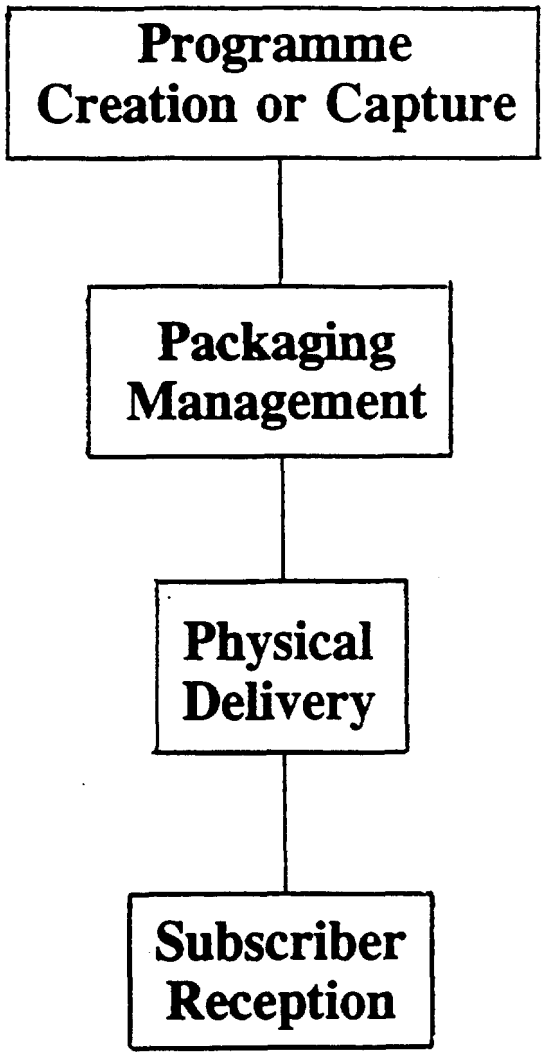
Service Delivery Chain



Philips Microwave

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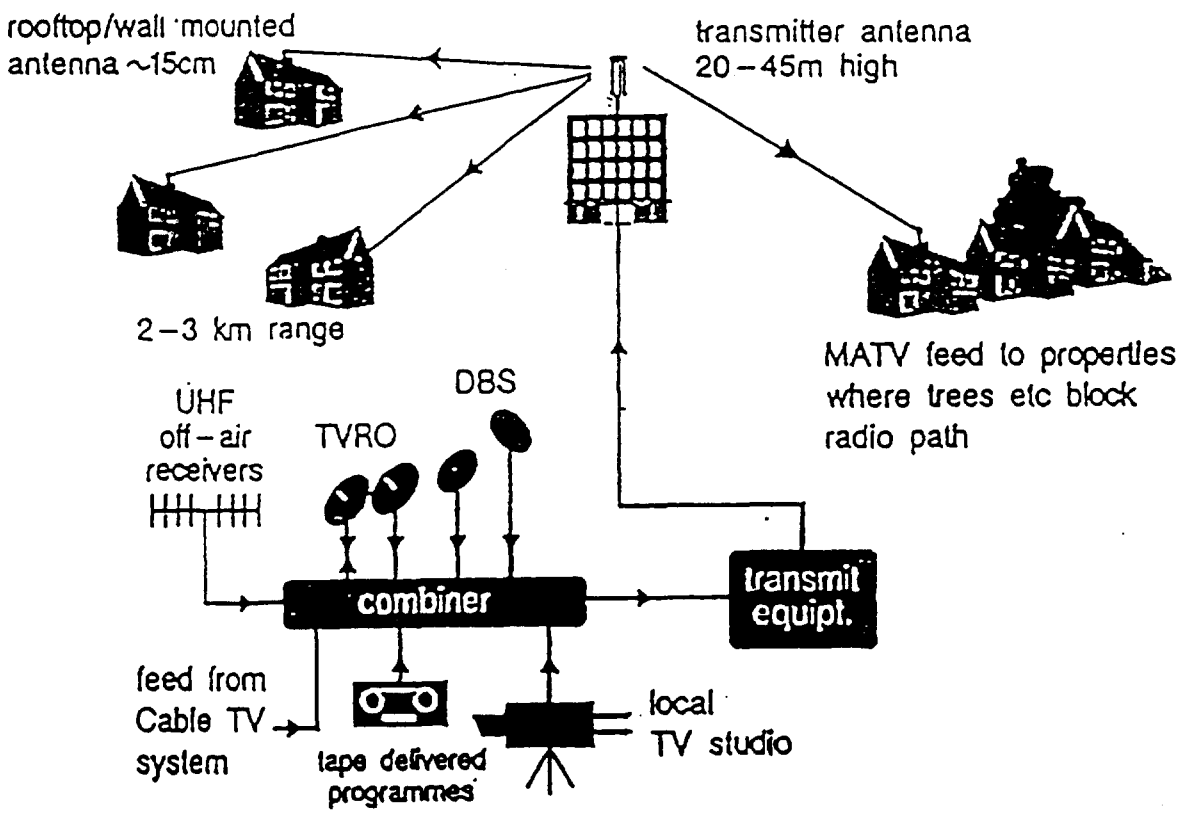
MVDS TRANSMISSION SYSTEM



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MVDS Position

* Cable-like features
  - Broad band
  - Interactive possibility
* DTH-like features
  - Speed
  - Low marginal cost

Where?

* Remote population pocket; Infill
* Sparsely populated areas
* Areas requiring rapid installation or upgrade

Why Today's Interest?

* **Market Fragmentation**

* **Deregulation / Competition**

* **Converging Markets**

  - **entertainment**
  - **telecommunications**
  - **financial services**

* **Maturing Technology**

Regulatory Position

* **World** - **ITU/WARC Broadcasting bands 12, 29, 42 GHz**

* **USA** - **MVDS Pioneer's Licence 29 GHz**

* **Europe** - **CEPT MVDS band 42 GHz**

* **UK** - **1990 Broadcasting Act LDO Licence Wireless Telegraphy Licence MPT 1550**

IBC 94

The UK technical and regulatory framework established for multipoint video distribution systems at 40 GHz

A V Harris
Radiocommunications Agency, UK
20 September 1994

System Design Aspects

- **Frequency modulation, 26 MHz channel bandwidth**
- **Commonality with Fixed Satellite Service / Direct To Home parameters**
- **29.5 MHz co-polar channel spacing**
- **14.75 MHz cross-polar channel interleaving**
- **4 channel groups of 32 channels, horizontal and vertical polarisations**
- **PAL/I and other transmission standards, digital transmission not precluded**